IS 4511-4 (1986): Methods of Test for Styrene-butadiene Rubber (SBR) Latices, Part 4: Determination of Bound Styrene SBRL : 9 [PCD 13: Rubber and Rubber Products]

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(Reaffirmed 2002)

Indian Standard

METHODS OF TEST FOR STYRENE-BUTADIENE RUBBER (SBR) LATICES

PART 4 DETERMINATION OF BOUND STYRENE SBRL : 9

(First Revision)

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BUREAU OF INDIAN STANDARDS
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NEW DELHI 110002

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Indian Standard

METHODS OF TEST FOR STYRENE-BUTADIENE RUBBER (SBR) LATICES

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(*First Revision*)

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Indian Standard

METHODS OF TEST FOR STYRENE-BUTADIENE RUBBER (SBR) LATICES

PART 4 DETERMINATION OF BOUND STYRENE SBRL : 9

(First Revision)

0. FOREWORD

0.1 This Indian Standard (Part 4) (First Revision) was adopted by the Indian Standards Institution on 28 February 1986, after the draft finalized by the Rubber Sectional Committee had been approved by the Petroleum, Coal and Related Products Division Council.

0.2 Test methods for rubber latex had been originally covered in the following Indian Standards:

For Natural Rubber Latex

IS : 3708 (Part 1)-1966*

IS : 3708 (Part 2)-1968†

For Styrene-Butadiene Rubber Latex

IS : 4511 (Part 1)-1967‡

Since some of the test methods covered in above standards were common, the concerned Committee had decided some years ago to unify and publish a separate series of methods of test which would be applicable to all types of latices — natural as well as synthetic. Accordingly, the following six test methods had been covered under IS : 9316.

IS : 9316 Methods of test for rubber latex:

(Part 1)-1979 Determination of surface tension

*Methods of test for natural rubber latex: Part 1 Dry rubber content, sludge content, density, total alkalinity, KOH-number, mechanical stability, volatile fatty acid number, *p*H, total nitrogen, total copper, total iron, total manganese and total ash.

†Methods of test for natural rubber latex, Part 2.

‡ Methods of tests for styrene-butadiene rubber (SBR) latices: Part 1 Determination of dry polymer, *p*H, density, residual styrene, bound styrene and soap content.

(Part 2)-1979 Determination of viscosity

(Part 3)-1979 Determination of coagulum content

(Part 4)-1979 Determination of total solids content

(Part 5)-1979 Drawing of samples

(Part 6)-1982 Determination of *p*H

0.2.1 As a result of further rethinking on the subject, it has now been decided to re-designate the test methods common to natural and synthetic rubber latices as RL series; test methods for natural rubber latex as NRL series and test methods for styrene-butadiene rubber latex as SBRL series. Consequently, test methods for rubber latex have been rationalized into the following three series:

a) IS : 9316 Unified methods of test applicable to both natural and synthetic rubber latices — RL series;

b) IS : 3708 Methods of test applicable to natural rubber latex — NRL series; and

c) IS : 4511 Methods of test applicable to styrene-butadiene rubber latex — SBRL series.

0.3 The existing Indian Standards under IS : 3708 (Part 1)-1966*, IS : 3708 (Part 2)-1968†, IS : 4511 (Part 1)-1967‡ and IS : 9316 (Parts 1 to 6) are being gradually replaced by separate standards under the above three series, designated by the appropriate NRL, SBRL or RL series respectively.

0.3.1 The methods covered under NRL : 13, NRL : 14 and NRL : 15 of IS : 3708 (Part 1)-1966 which are also under revision, have been proposed to be covered under the RL series in IS : 9316 (*under revision*).

0.4 In order to facilitate cross-reference, it has been decided to retain the original discrete SBRL series numbers assigned to various test methods in IS : 4511 (Part 1)-1967‡ in the revised Parts of IS : 4511.

0.4.1 For proper referencing of the existing test methods and the new methods under revision, a statement showing corresponding methods is given in Appendix A.

*Methods of test for natural rubber latex: Part 1 Dry rubber content, sludge content, density, total alkalinity, KOH-number, mechanical stability, volatile fatty acid number, *p*H, total nitrogen, total copper, total iron, total manganese and total ash.

†Methods of test for natural rubber latex, Part 2.

‡Methods of tests for styrene-butadiene rubber (SBR) latices: Part 1 Determination of dry polymer, *p*H, density, residual styrene, bound styrene and soap content.

0.5 In preparing the above series, the need to align the test methods with the corresponding ISO Standards/DIS/DP wherever available has also been taken into account for updating the test methods. In the preparation of this standard, assistance has been derived from ISO 3136-1983 'Rubber, latex-styrene-butadiene — Determination of bound styrene content, issued by the International Organization for Standardization (ISO).

0.6 In reporting the result of a test or analysis made in accordance with this standard, if the final value, observed or calculated, is to be rounded off, it shall be done in accordance with IS : 2-1960*.

1. SCOPE

1.1 This standard (Part 4) prescribes a method for the determination of the bound styrene content of styrene-butadiene rubber (SBR) latices.

1.2 The method is applicable to hot (approximately 50°C) emulsion polymerized SBR latices having a bound styrene content, expressed on the SBR content, of up to 55 percent and to cold (approximately 5°C) emulsion polymerized SBR latices having a bound styrene content between 18 and 40 percent.

1.3 The method is not applicable to reinforced styrene-butadiene rubber (SBR..Y) latices, carboxylated-styrene-butadiene rubber (XSBR) latices and pyridine-butadiene rubber (PSBR) latices.

2. OUTLINE OF THE METHOD

2.1 Styrene-butadiene rubber latex is coagulated by the addition of salt, methanol and acid. The resulting crumb is filtered and dried. A portion of this rubber is subjected to exhaustive extraction by the use of ethanol-toluene azeotrops (ETA). The extracted rubber is vacuum dried and then pressed between sheets of aluminium foil. Strips of rubber are pressed against the prism of a refractometer and the index of refraction measured. The percentage bound styrene is calculated from a table of known values at a given refractive index and temperature.

3. APPARATUS

3.1 Spiders — consisting of 13 mm squares of sheet aluminium or stainless steel having a nickel-chromium wire leg about 38 mm long attached to each corner. When the extracting solvent is ETA acidified with hydrochloric acid, the spider and the legs shall be made of tantalum.

*Rules for rounding off numerical values (*revised*).

3.2 Reflux Condenser

3.3 Abbe-Type Refractometer — having fourth decimal place accuracy and whose refracting prism may be placed in a nearly horizontal position for measurement of the refractive index of solids. An Amici-type compensating prism for achromatization is necessary unless a sodium-vapour lamp is used as light source. The refractometer shall be maintained at a known temperature, preferably 25°C, obtained by the use of a constant temperature room or by circulating constant temperature water through the instrument. The temperature shall be held constant to within ± 0·1 C.

3.4 Vacuum Oven — capable of being evacuated to a pressure of 1 300 N/m^2 (10 mmHg) and of maintaining a temperature of 100 ± 5°C.

3.5 Aluminium Foil — between 0·025 and 0·080 mm thick, having good tear strength.

3.6 Glass Standard — for checking adjustment of the refractometer. The glass standard should be calibrated for use at 25°C.

3.7 Hydraulic Press — That may be maintained at a temperature of 100°C and may attain a total force up to 100 kN (22 000 lbf) on the platens.

3.8 Pressing Plate (Optional Apparatus) — 210 mm × 210 mm × 3 mm with a wooden handle. One of the plates shall have a 150 mm square area in the centre milled out to a depth not to exceed 0·65 mm.

3.9 Scissors — small and sharp.

3.10 Light Source — which shall be collimated to provide a beam at grazing incidence to the prism. If an incandescent light source is used, such as a flashlight bulb, it shall be of low intensity. A sodium-vapour lamp may also be used. The light source requirement is that a clear, sharp line with good contrast should be observed in the telescope of the refractometer. Attenuation or diffusion of the light for better viewing may be accomplished by placing crumpled tissue paper in the light path.

3.11 Combined High-Speed Mechanical Stirrer and Comminutor — With a totally enclosed motor, and with a stirrer vessel of capacity at least 1 000 ml.

3.12 Cheesecloth

3.13 Drying Tray — preferably of stainless steel wire gauze.

3.14 Forced-Draught Oven — capable of being controlled at a temperature between 100 and 125°C.

4. REAGENTS

4.1 Sodium Chloride Solution — 20 percent solution of analytical reagent grade sodium chloride (*m/m*).

4.2 Antioxidant Solution — Prepare a 0·75 percent (*m/m*) methanolic solution of a bis- or polyphenol type of antioxidant which shall prevent oxidation of the polymer during its preparation.

4.3 Sulphuric Acid Solution — Add 1 volume of concentrated sulphuric acid (*see* IS : 266-1977*) to 9 volumes of water.

4.4 Congo Red Indicator Paper

4.5 Ethanol-Toluene Azeotrope (ETA) — Mix 7 volumes of absolute ethanol (*see* IS : 321-1964†) with 3 volumes of toluene. Alternatively, mix, 7 volumes of commercial grade ethanol with 3 volumes of toluene (*see* IS : 1839-1961‡), and boil the mixture with anhydrous calcium oxide (quicklime) under reflux for 4 hours, then distil the azeotrope and collect the fraction with a boiling range not exceeding 1°C, for use in the test.

4.6 Acidified Ethanol Toluene Azeotrope — Add 10 ml of concentrated hydrochloric acid [approximately 35 percent (*m/m*)] to a definite amount of ETA (4·5) and make the solution up to 1 000 ml with ETA.

NOTE — Acidified ETA is used for alum-coagulated polymers.

4.7 α-Bromonaphthalene

5. PROCEDURE

5.1 Coagulation Procedure — If the total solids content is not known, determine it in accordance with IS : 9316 (Part 4)-1979§. If the total solids content of the latex is greater than 30 percent, dilute the latex with water to a total solids content of 30 percent. To 250 ml of the latex contained in the stirrer vessel, add 50 ml of the sodium chloride solution and mix thoroughly. With continuous stirring, add 250 ml of the

*Specification for sulphuric acid (*second revision*).

†Specification for absolute alcohol (*revised*).

‡Specification for toluene, reagent grade.

§Methods of test for rubber latex: Part 4 Determination of total solids content.

antioxidant solution and slowly add, during 2 to 3 min, 10 ml of the sulphuric acid solution. Test with the indicator paper and if its colour does not change from red to blue, add additional sulphuric acid, with stirring, until the colour does change. Pour the contents of the stirrer vessel on to the cheesecloth and press as much liquid as possible from the crumb. Separate the mass of crumb by hand, wash it with water and transfer the pieces to the drying tray.

5.2 Drying Procedure — Dry the crumb in the oven at $105 \pm 2°C$ to a constant mass. The drying time depends upon the consistency of the crumb, the properties of the polymer and the oven conditions, and shall be determined by experiment.

5.3 Preparation of Test Pieces

5.3.1 Sheet out the polymer to a thickness of no greater than 0·5 mm. Cut the sheeted polymer into strips approximately 13 mm wide and 25 mm long. Fasten one strip to each leg of the spider thus allowing each portion of the rubber to be contacted on all sides by the solvent. Place the spider and strips in a 400-ml flask into which 60 ml of ETA have been placed (for alum-coagulated polymers, use acidified ETA and tantalum spiders). Fit the reflux condenser in position. Extract for one hour at a temperature at which the solvent boils gently. Replace the solution with another 60 ml of ETA or acidified ETA and extract for an additional hour, remove the spider from the flask and dry the rubber to constant mass in the vacuum oven, maintained at a pressure of about 1 300 N/m^2 (10 mm Hg) and a temperature of $100 \pm 5°C$.

NOTE 1 — It is important that the test pieces be extracted and dried thoroughly since either residual solvent or incompletely extracted materials would result in erroneous readings of the refractive index.

NOTE 2 — Avoid plasticizing of the sample by overheating.

5.3.2 After the test pieces have been thoroughly dried, remove them from the spiders. At this point, any one of the several techniques is suitable for pressing the test piece. The method of pressing may be modified to suit the type of polymer and the type of equipment available. The pressure and the time of pressing at 100°C may be varied. The test piece may be cooled to room temperature under pressure, or removed from the press while hot. The time of hot pressing shall never exceed 10 min, and should preferably be 5 min.

The conditions shall be chosen so that the pressed test piece is homogeneous and so that a distinct line can be observed dividing the light and dark fields of the telescope field when the refractive index is determined. Two general techniques are given for the pressing operation.

5.3.2.1 If pressing plates as given in **3.8** are used, proceed as follows:

Place approximately 0·3 g of the dry extracted polymer between two sheets of aluminium foil about 50 mm^2 and fold the corners over once. Place this test piece between the pressing plates and place the plates in the press held at 100°C. Close the platens without applying pressure and preheat for 1 min. Several test pieces may be pressed at one time. Apply a force of about 100 kN (22 000 lbf) for 3 min. Release the pressure, remove the test pieces from the press and allow them to cool.

5.3.2.2 If the pressing is to be done between flat platens without a cavity, proceed as follows, modifying the details of the procedure to suit the sample:

Prepare approximately 25 mm^2 of the clean aluminium foil. Place a portion of one of the dried strips between two pieces of foil. Press the test piece between the foil squares with a force of between 2·2 and 6·6 kN (500 and 1 500 lbf) at 100°C for 3 to 10 min (preferably 3 to 5 min). If several test pieces are pressed at one time, increase the applied force proportionally so that the pressure on each test piece is between about 3·45 and 10·35 MN/m^2 (500 and 1 500 lbf/in^2). Forces lower than the usual limit may be necessary for some polymers. It may also be necessary, with some polymers, to allow the pressed test pieces to cool under pressure while cooling the platens with cold water.

5.3.3 The thickness of the final test pieces to be measured shall not exceed 0·5 mm and may be much thinner. The ability to handle the pressed test piece and obtain a good refractive index reading are the only requirements with respect to test piece thickness.

5.3.4 Cut the prepared test piece in half with sharp scissors and peel off one piece of the foil. Cut off a strip about 6 mm wide by 12 mm long with the scissors, in such a way that one of the narrower ends is freshly cut. The second piece of foil may be removed but it is frequently easier to handle the test piece with one foil piece left on the rubber.

5.4 Determination of Bound Styrene

5.4.1 Check that the temperature of the refractometer has stabilized at 25°C.

5.4.2 Check the adjustment of the refractometer by means of the glass standard pressed firmly against the prism, using a drop of α-bromonaphthalene for contact liquid. The small light source shall be collimated and the best readings are obtained with the glass standard if the light is diffused through crumpled tissue paper. Move the hand control until the boundary line just reaches the cross-hairs (always moving from the light

into the dark field). Make at least three readings. Adjust the instrument to give the reading of the glass standard. After this adjustment, clean the prism well with ethanol and a lens paper.

5.4.3 Place the test piece on the prism with the cut edge toward the light source approximately where the glass standard was positioned. Remove the tissue paper from the light source. Press the test piece firmly on the prism by means of the finger and wait 1 min for temperature equilibrium. It is also permissible to close the upper prism on the test piece lightly if adequate light can still be focussed on the end of the test piece, but unless the test piece is very thin this operation can damage the prism or its mounting. Adjust the compensating prism until a sharp dividing line between light and dark fields with minimum colour is obtained. Test the contact between rubber and prism by pressing the test piece against the prism. There shall be no change in the position of the boundary line during this test.

5.4.4 Make at least three readings. If the readings differ by more than 0·000 1, further readings are necessary.

5.4.5 Repeat the process of obtaining readings with another portion of the test piece having a freshly cut edge. Average the mean values of the two sets of readings thus obtained. If the two mean values do not differ by more than 0·000 2, use this average for the calculation in accordance with **6**. If the difference is more than 0·000 2, the procedure shall be repeated. If necessary, correct the refractive index measurement to 25°C using the following equation:

$$n_{25} = n_\theta + 0{\cdot}000\ 37\ (\theta - 25)$$

where

n_{25} = refractive index at 25°C;

n_θ = refractive index at temperature of measurement; and

θ = temperature of measurement, in degrees Celsius.

6. CALCULATION

6.1 The bound styrene content, S, of the SBR content of the latex, expressed as a percentage by mass, is determined from the refractive index, corrected to 25°C, by using the following equation or Table 1 :

$$S = 23{\cdot}50 + 1\ 164\ (n_{25} - 1{\cdot}534\ 56) - 3\ 497\ (n_{25} - 1{\cdot}534\ 56)^2$$

TABLE 1 VALUES OF REFRACTIVE INDEX AND PERCENT BOUND STYRENE

(*Clause* 6.1)

Refractive Index at 25°C n_{25}	0	1	2	3	4	5	6	7	8	9
					(Percent Bound Styrene)					
1·515	—	—	—	—	—	0·05	0·18	0·31	0·44	0·57
1·516	0·70	0·83	0·96	1·09	1·22	1·34	1·47	1·60	1·73	1·86
1·517	1·99	2·12	2·25	2·37	2·50	2·63	2·76	2·89	3·02	3·14
1·518	3·27	3·40	3·53	3·66	3·78	3·91	4·04	4·17	4·29	4·42
1·519	4·55	4·67	4·80	4·93	5·06	5·18	5·31	5·44	5·56	5·69
1·520	5·82	5·94	6·07	6·20	6·32	6·45	6·57	6·70	6·83	6·95
1·521	7·08	7·20	7·33	7·46	7·58	7·71	7·83	7·96	8·08	8·21
1·522	8·33	8·46	8·58	8·71	8·83	8·96	9·08	9·21	9·33	9·46
1·523	9·58	9·71	9·83	9·95	10·08	10·20	10·33	10·45	10·57	10·70
1·524	10·82	10·95	11·07	11·19	11·32	11·44	11·56	11·69	11·81	11·93
1·525	12·06	12·18	12·30	12·43	12·55	12·67	12·79	12·92	13.04	13·16
1·526	13·28	13·41	13·53	13·65	13·77	13·89	14·02	14·14	14·26	14·38
1·527	14·50	14·62	14·75	14·87	14·99	15·11	15·23	15·35	15·47	15·60
1·528	15·72	15·84	15·96	16·08	16·20	16·32	16·44	16·56	16·68	16·80
1·529	16·92	17·04	17·16	17·28	17·40	17·52	17·64	17·76	17·88	18·00
1·530	18·12	18·24	18·36	18·48	18·60	18·72	18·84	18·96	19·08	19·19
1·531	19·31	19·43	19·55	19·67	19·79	19·91	20·03	20·14	20·26	20·38
1·532	20·50	20·62	20·73	20·85	20·97	20·09	21·21	21·32	21·44	21·56
1·533	21·68	21·79	21·91	22·03	22·15	22·26	22·38	22·50	22·61	22·73
1·534	22·85	22·96	23·08	23·20	23·31	23·43	23·55	23·66	23·78	23·90
1·535	24·01	24·13	24·24	24·36	24·47	24·59	24·71	24·82	24·94	25·05
1·536	25·17	25·28	25·40	25·51	25·63	25.74	25·86	25·97	26·09	26·20
1·537	26·32	26·43	26·55	26·66	26·78	26·89	27·00	27·12	27·23	27·35
1·538	27·46	27·58	27·69	27·80	27·92	28·03	28·14	28·26	28·37	28·48
1·539	28·60	28·71	28·82	28·94	29·05	29·16	29·28	29·39	29·50	29·61

(*Continued*)

TABLE 1 VALUES OF REFRACTIVE INDEX AND PERCENT BOUND STYRENE — *Contd*

Refractive Index at 25°C n_{25}	0	1	2	3	4	5	6	7	8	9
					(Percent Bound Styrene)					
1·540	29·73	29·84	29·95	30·06	30·18	30·29	30·40	30·51	30·62	30·74
1·541	30·85	30·96	31·07	31·18	31·30	31·41	31·52	31·63	31·74	31·85
1·542	31·96	32·07	32·19	32·30	32·41	32·52	32·63	32·74	32·85	32·96
1·543	33·07	33·18	33·29	33·40	33·51	33·62	33·73	33·84	33·95	34·06
1·544	34·17	34·28	34·39	34·50	34·61	34·72	34·83	34·94	35·05	35·16
1·545	35·27	35·38	35·48	35·59	35·70	35·81	35·92	36·03	36·14	36·25
1·546	36·35	36·46	36·57	36·68	36·79	36·89	37·00	37·11	37·22	37·33
1·547	37·43	37·54	37·65	37·76	37·86	37·97	38·08	38·19	38·29	38·40
1·548	38·51	38·61	38·72	38·83	38·93	39·04	39·15	39·25	39·36	39·47
1·549	39·57	39·68	39·79	39·89	40·00	40·10	40·21	40·32	40·42	40·53
1·550	40·63	40·74	40·84	40·95	41·05	41·16	41·26	41·37	41·47	41·58
1·551	41·68	41·79	41·89	42·00	42·10	42·21	42·31	42·42	42·52	42·63
1·552	42·73	42·83	42·94	43·04	43·15	43·25	43·35	43·46	43·56	43·66
1·553	43·77	43·87	43·97	44·08	44·18	44·28	44·39	44·49	44·59	44·70
1·554	44·80	44·90	45·00	45·11	45·21	45·31	45·41	45·52	45·62	45·72
1·555	45·82	45·92	46·03	46·13	46·23	46·33	46·43	46·54	46·64	46·74
1·556	46·84	46·94	47·04	47·14	47·25	47·35	47·45	47·55	47·65	47·75
1·557	47·85	47·95	48·05	48·15	48·25	48·35	48·45	48·55	48·65	48·75
1·558	48·85	48·95	49·05	49·15	49·25	49·35	49·45	49·55	49·65	49·75
1·559	49·85	49·95	50·05	50·15	50·25	50·35	50·44	50·54	50·64	50·74
1·560	50·84	50·94	51·04	51·13	51·23	51·33	51·43	51·53	51·63	51·72
1·561	51·82	51·92	52·02	52·11	52·21	52·31	52·41	52·50	52·60	52·70
1·562	52·80	52·89	52·99	53·09	53·18	53·28	53·38	53·47	53·57	53·67
1·563	53·76	53·86	53·96	54.05	54·15	54·25	54 34	54·44	54 53	54·63
1·564	54·73	54·82	54·92	55·01	55·11	55·20	55.30	55·39	55·49	55·58

APPENDIX A

(*Clause* 0.4.1)

TABLE SHOWING CORRESPONDENCE OF THE VARIOUS METHODS OF TEST COVERED IN THE EXISTING IS : 9316 (PARTS 1 TO 5)-1979, IS : 9316 (PART 6)-1982, IS : 3708 (PART 1)-1966, IS : 3708 (PART 2)-1968, IS : 4511 (PART 1)-1967 *WITH* THE REVISION/PROPOSED REVISION OF IS : 9316, IS : 3708 AND IS : 4511

Existing Test Methods			Proposed Revision		Remarks
Test Method	IS No.	Part (Series)	IS No.	Series	
(1)	(2)	(3)	(4)	(5)	(6)
RL Series					
Determination of surface tension	IS : 9316-1979	Part 1	IS : 9316	Part 1 (RL : 1)	
Determination of viscosity	IS : 9316-1979	Part 2	IS : 9316	Part 2 (RL : 2)	
Determination of coagulum content	IS : 9316-1979	Part 3	IS : 9316	Part 3 (RL : 3)	
Determination of total solids content	IS : 9316-1979	Part 4	IS : 9316	Part 4 (RL : 4)	
Drawing of samples	IS : 9316-1979	Part 5	IS : 9316	Part 5 (RL : 5)	Under revision
Determination of *p*H	IS : 9316-1982	Part 6	IS : 9316	Part 6 (RL : 6)	
Determination of total copper	IS : 3708-1966	Part 1 (NRL : 13)	IS : 9316	Part 7 (RL : 7)	
Determination of total iron	IS : 3708-1966	Part 1 (NRL : 14)	IS : 9316	Part 8 (RL : 8)	
Determination of total manganese	IS : 3708-1966	Part 1 (NRL : 15)	IS : 9316	Part 9 (RL : 9)	
NRL Series					
Determination of dry rubber content	IS : 3708-1966	Part 1 (NRL : 1)	IS : 3708-1985	Part 1 (NRL : 1)	
Determination of sludge content	IS : 3708-1966	Part 1 (NRL : 5)	IS : 3708-1985	Part 2 (NRL : 5)	
Determination of density	IS : 3708-1966	Part 1 (NRL : 6)	IS : 3708-1985	Part 3 (NRL : 6)	
Determination of total alkalinity	IS : 3708-1966	Part 1 (NRL : 7)	IS : 3708-1985	Part 4 (NRL : 7)	

(*Continued*)

Existing Test Methods			Proposed Revision		Remarks
Test Method	IS No.	Part (Series)	IS No.	Series	
(1)	(2)	(3)	(4)	(5)	(6)
Determination of KOH-number	IS : 3708-1966	Part 1 (NRL : 8)	IS : 3708-1985	Part 5 (NRL : 8)	
Determination of mechanical stability	IS : 3708-1966	Part 1 (NRL : 9)	IS : 3708-1985	Part 6 (NRL : 9)	
Determination of volatile fatty acid number	IS : 3708-1966	Part 1 (NRL : 10)	IS : 3708-1986	Part 7 (NRL : 10)	
Determination of total nitrogen	IS : 3708-1966	Part 1 (NRL : 12)	IS : 3708-1986	Part 8 (NRL : 12)	
Determination of total ash	IS : 3708-1966	Part 1 (NRL : 16)	IS : 3708-1986	Part 9 (NRL : 16)	
Determination of boric acid	IS : 3708-1968	Part 2 (NRL : 17)	IS : 3708-1986	Part 10 (NRL : 17)	
Determination of magnesium	IS : 3708-1968	Part 2 (NRL : 18)	IS : 3708-1986	Part 11 (NRL : 18)	
SBRL Series					
Determination of dry polymer	IS : 4511-1967	Part 1 (SBRL : 1)	IS : 4511-1986	Part 1 (SBRL : 1)	
Determination of density	IS : 4511-1967	Part 1 (SBRL : 6)	IS : 4511-1986	Part 2 (SBRL : 6)	
Determination of residual styrene (volatile unsaturates)	IS : 4511-1967	Part 1 (SBRL : 8)	IS : 4511-1986	Part 3 (SBRL : 8)	Under revision
Determination of bound styrene	IS : 4511-1967	Part 1 (SBRL : 9)	IS : 4511-1986	Part 4 (SBRL : 9)	
Determination of soap content	IS : 4511-1967	Part 1 (SBRL : 10)	IS : 4511-1986	Part 5 (SBRL : 10)	Under revision

(*Continued from page* 2)

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INTERNATIONAL SYSTEM OF UNITS (SI UNITS)

Base Units

Quantity	Unit	Symbol
Length	metre	m
Mass	kilogram	kg
Time	second	s
Electric current	ampere	A
Thermodynamic temperature	kelvin	K
Luminous intensity	candela	cd
Amount of substance	mole	mol

Supplementary Units

Quantity	Unit	Symbol
Plane Angle	radian	rad
Solid angle	steradian	sr

Derived Units

Quantity	Unit	Symbol	Definition
Force	newton	N	1 N = 1 kg.m/s^2
Energy	joule	J	1 J = 1 N.m
Power	watt	W	1 W = 1 J/s
Flux	weber	Wb	1 Wb = 1 V.s
Flux density	tesla	T	1 T = 1 Wb/m^2
Frequency	hertz	Hz	1 Hz = 1 c/s (s^{-1})
Electric conductance	siemens	S	1 S = 1 A/V
Electromotive force	volt	V	1 V = 1 W/A
Pressure, stress	pascal	Pa	1 Pa = 1 N/m^2

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